MINING METHODS AND COSTS, SCHWARTZWALDER URANIUM MINE, JEFFERSON COUNTY, COLO.

By J. H. Soulé

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MINING METHODS AND COSTS, SCHWARTZWALDER URANIUM MINE, JEFFERSON COUNTY, COLO.[1]

by

J. H. Soulé[2]

SUMMARY

This information circular is one of a series published by the Federal Bureau of Mines describing methods and costs at various mining operations. The Schwartzwalder uranium mine, situated about 20 miles west of Denver, Colo., is an important source of uranium ore in the Front Range. Production was begun in 1953, and nearly 36,500 tons of ore had been shipped by September 1, 1958. The mine is operated by Denver-Golden Oil & Uranium Co., Denver, Colo.

Much interest has been shown in the property since uranium mineralization was found by Fred Schwartzwalder in 1949. The Atomic Energy Commission, Federal Geological Survey, Office of Minerals Exploration (formerly Defense Minerals Exploration Administration), and Federal Bureau of Mines have done work in the area, and various private concerns have shown interest in the property.

The ore occurs in veins that occupy fault fissures in Precambrian metamorphic rocks. The veins appear confined to certain lithologic members of the contorted gneisses and schists. Ore deposition seems to have been controlled by structural and chemical factors.

The length of the ore bodies along the strike rarely exceeds 150 feet, and the width (averaging about 6 feet) may be as much as 28 feet. Dips usually are steep--in excess of 55°--and may be northeast or southwest.

The first prospecting was done by trenching and driving short adits. Most exploration now is done by core drilling. Radiation-counter readings, checked by chemical analyses, are used to determine the quality of the ore. All underground mining is guided by the counter results, and indicated marginal ore is checked by quantitative chemical analyses.

Early development was by adits and raises that were connected to a higher level before stoping. As driving adits below the present lowest level was not feasible because of the topography, a winze was sunk to reach lower levels. The winze is now 285 feet below the Steve or lowest adit level. The winze was

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[1] Work on manuscript completed August 1959.

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timbered to divide it into two compartments for use as an underground shaft. One compartment will be used for hoisting ore and lowering supplies; the other compartment will serve as a manway and serviceway. Levels are planned 125 and 250 feet below the adit. Ore is mined by shrinkage stoping as the walls are firm and stand well.

The broken rock is hand trammed, as hauling distances are short. The mine is equipped with 20-cubic-foot cars, on 16-pound rail set to 18-gage. Established grades usually are 1 percent in favor of the load.

The mine has electric power, and all major equipment is electrically operated. Electricity also is used for underground lighting, and electric blasting was used in sinking the winze. The current is brought to the mine at 13,000 volts and stepped down for mine use; about 400 horsepower is available.

Most mining is done under contract. A unit price is paid for all mine development and stoping. Regular pay is guaranteed, and all supplies and equipment are furnished by the company. Thirty-four men working two shifts are employed daily.

Partial information on the costs of development work indicated a cost of $25.51 per foot for driving the Steve adit. The cost of sinking and tembering the winze or underground shaft was $113.30 per foot, which included the cost of stations on the 125- and 250-foot levels. The cost of explosives for development and mining was $0.55 per ton of broken ore and waste; about 2.24 pounds of explosives was consumed per ton of ore and waste broken. A total cost of $8.27 per ton was indicated for ore and waste broken, or $11.32 per ton of ore sent to the bins. About 2.95 tons of ore and waste are broken per man-shift.

INTRODUCTION

The Schwartzwalder mine is the most important source of uranium ore in the Front Range. The ore deposits and methods of mining differ from those on the Colorado Plateau.

ACKNOWLEDGMENTS

The management and staff of Denver-Golden Oil & Uranium Co. cooperated and helped in the preparation of this paper. Acknowledgment is due Charles O. Parker, president; G. H. Brodie, vice-president; Edgar C. Rice, manager; Clyde I. True, superintendent; and Allan G. Bird, geologist, for their assistance. Special acknowledgment is due the operating staff for furnishing cost figures.

LOCATION AND PHYSICAL FEATURES

The Schwartzwalder mine, also known as the Ralston Creek mine, is in SE$\frac{1}{4}$ sec. 25, T. 2 S., R. 71 W., northwestern Jefferson County, Colo. (See fig. 1.) The mine is about 7 miles by road north-northwest of Golden, Colo., and approximately 24 miles by road from Denver. Except for the first mile, the road from Golden to the mine is unpaved; the last mile of road has steep grades and sharp curves, which limit the size of truck that can reach the mine even though the

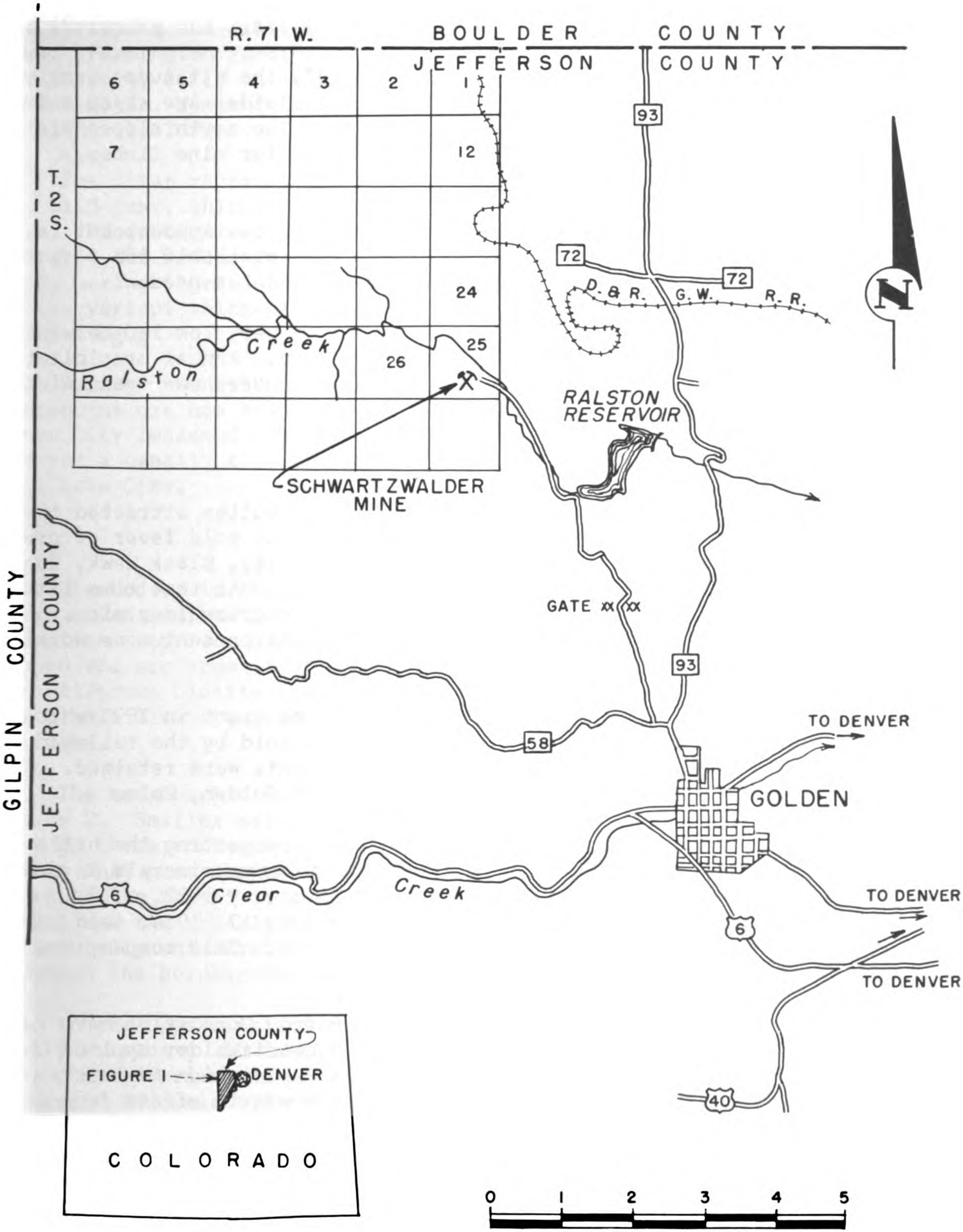

FIGURE 1. - Location Map, Schwartzwalder Mine, Jefferson County, Colo.

road is well maintained. Ore is hauled in a small dump truck about 3 miles from the mine and then transferred to a large truck for transportation to the Cotter mill at Canon City, Colo., a distance of 145 miles.

The mine is in an area of moderately high relief, the altitudes ranging from about 6,400 to 7,788 feet near the mine. The hillsides are steep and are very rugged at Ralston Buttes northeast of the mine. The north slopes are covered with timber, largely spruce, which can be used for mine timber. Grasses and various shrubs abound.

The flow of Ralston Creek, just below the mine, is continuous, but is small during the dry seasons. Enough surface water is available for a small mining operation; the mine now discharges more water than is used.

Temperatures range from moderate in the summer to very low in the winter, but extremely cold spells usually are of short duration. Annual precipitation averages about 18 inches and is derived from summer thundershowers and winter snows. Snowfall averages about 60 inches per year.

HISTORY AND PRODUCTION

Probably the copper-stained outcrops near Ralston Buttes attracted the attention of prospectors who swarmed the hills during the gold fever of pre-1900. This activity accompanied the booms at Central City, Black Hawk, Idaho Springs, Georgetown, and other towns in the Front Range. At that time little or no work was done on what was later to become the Schwartzwalder mine. A few shallow prospect adits and cuts were driven, but all present mine workings date from 1953.

Union Pacific Railroad Co. received a Federal land grant in 1898 which included sec. 25, T. 2 S., R. 71 W. This section was sold by the railroad company in 1907 to Golden Mining Co., but the coal rights were retained. The section is now owned by Paul R. and Anna Lee White, of Golden, Colo.

Fred Schwartzwalder, of Golden, Colo., had been prospecting the hills around Golden for many years and in 1949 discovered uranium minerals in outcrops and old dumps in the Ralston Creek area. In February 1953, Schwartzwalder leased part of section 25 and on February 17, 1956, sold his rights to Denver-Golden Oil & Uranium Co., Denver, Colo. This company now leases all of section 25 from the Whites.

The Federal Geological Survey and the Atomic Energy Commission have been interested in the Ralston Creek area since 1950. Schwartzwalder applied for Federal assistance from the former Defense Minerals Exploration Administration. Assistance was granted in an exploration project that was in effect from September 2, 1953, until June 2, 1955. The Government contributed $15,705.67 to the cost of the project, which consisted of building 1.7 miles of access road, 300 feet of trenching and stripping, rehabilitating the Ralston Creek (upper) adit, constructing a small shed for shop and changehouse, and 399 feet of drifting and crosscutting. A discovery was made and certified, and the Government's share of the cost was repaid on October 3, 1955.

After preliminary examinations and mapping, the Atomic Energy Commission, from April 21, 1954 to March 15, 1955, did 992 hours of bulldozer trenching and stripping and drilled nine diamond-drill holes aggregating about 2,756 feet. Farmington Funding Co., of Colorado Springs, Colo., took an option on the property early in 1955 and drilled two diamond-drill holes totaling 1,800 feet. Later, Newmont Exploration Co. drilled 6 holes, 80 to 337 feet deep, totaling 1,157 feet.

The first recorded uranium-ore production from the Schwartzwalder mine was 51.3 tons, shipped on December 4, 1953, to a mill near Salt Lake City, Utah. Production was 661.0 tons in 1954, 918.8 tons in 1955, 11,151.6 tons in 1956, 14,832.0 tons in 1957, and 8,866.3 tons during the first 8 months of 1958, making a grand total of 36,481 tons as of September 1, 1958. The grades of the various shipments ranged from a low of 0.39 percent to a high of 1.32 percent U_3O_8.

During June 1958, shipments to Salt Lake City were discontinued, and all subsequent ore has been sent to a new mill near Canon City, Colo. Shipping to Canon City lessened haulage costs, enabled the operators to ship more ore, and removed a penalty assessed on ores metallurgically unsuitable for the mill at Salt Lake City.

GENERAL GEOLOGY[3]

Ore bodies in the Schwartzwalder mine occur in Precambrian metamorphic rocks which compose part of the Idaho Springs formation. Near the mine this formation comprises gneisses and schists. Six lithologic units have been mapped and are shown in figure 2. The six units are: Quartz-muscovite schist, garnetiferous biotite gneiss, phyllitic schist, chlorite schist, metaquartzite, and lime silicate gneiss hornblende schist. Some granite pegmatite occurs in the area.

The metamorphic series has been deformed into a large fold, as shown in figure 2. Smaller deformations also are noted. Subsequent faulting cut through these rocks, and uranium mineralization is localized in parts of these faults that pass through the garnetiferous biotite gneiss and transitional rocks of the phyllitic schist. In this area, the overlying quartz-muscovite schist and the underlying lime silicate gneiss hornblende schist appear to be structurally unfavorable for the formation of commercial uranium deposits, although the hornblende schist is chemically favorable.

In the upper part of the mine the ore bodies are short, the strike length rarely exceeding 150 feet. The ore bodies have a maximum thickness of 28 feet and often comprise numerous more or less parallel veins or veinlets. Most of the veins and vein systems dip east to northeast at 55° or steeper. (See fig. 3.) The Illinois and Washington veins dip west in excess of 60° (fig. 4). The Flat vein in the upper adit which is the site of the first mining, dips southwest where it joins the Nebraska vein.

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[3] Bird, Allan G., Masters Thesis, 1958, Department of Geology, University of Colo. Abstracted.

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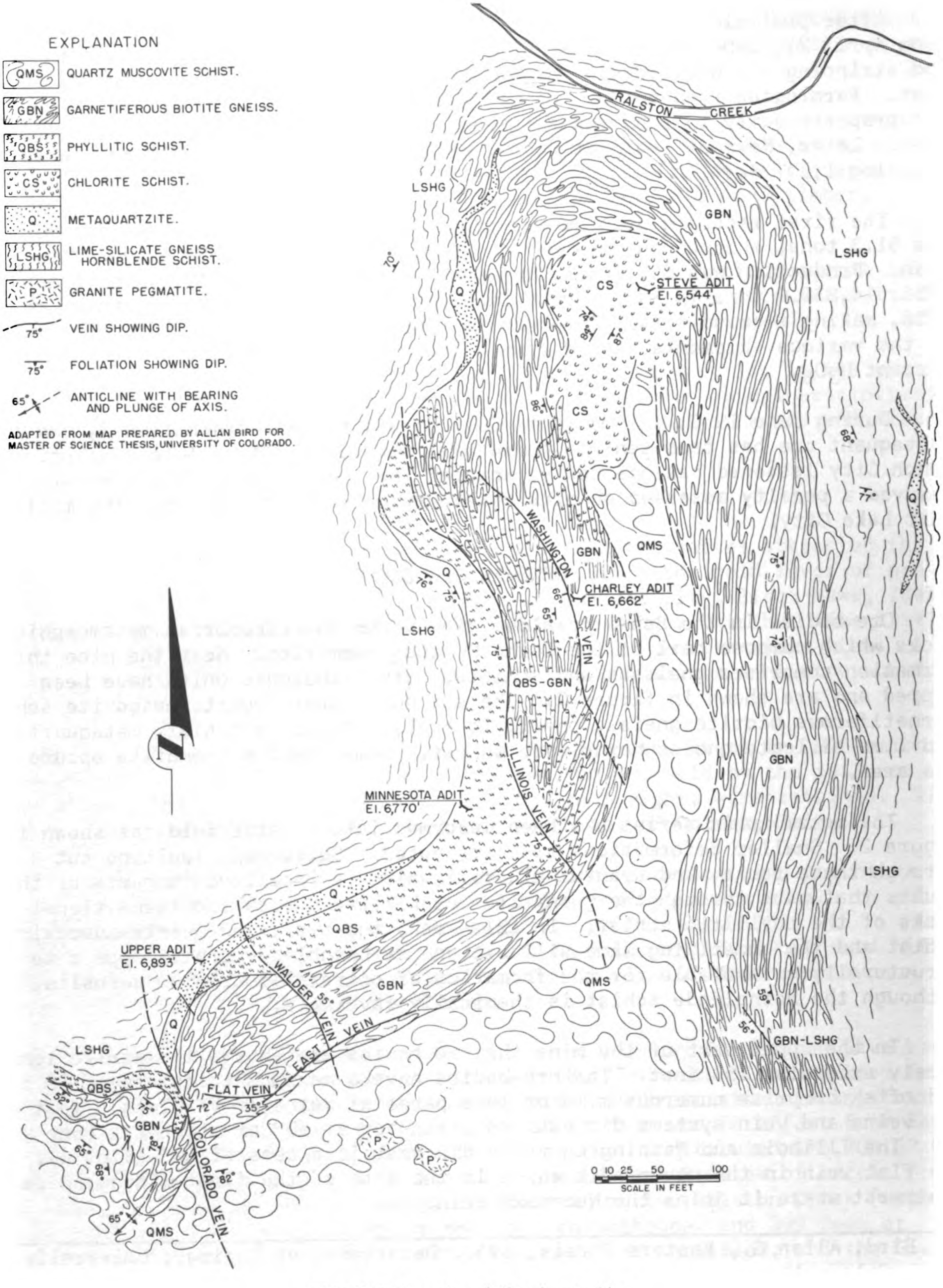

FIGURE 2. - Areal Geologic Map.

Ore minerals are pyrite, tennantite, emplectite, chalcopyrite, pitchblende, sphalerite, galena, and some oxidized minerals derived from the primary minerals. Only the pitchblende occurs in commercial quantities. Gangue minerals are ankerite, calcite, potassium feldspar, quartz, and chlorite.

METHODS OF PROSPECTING AND EXPLORATION

The first prospecting was done with pick and shovel; later, the geiger counter and scintillation counter were also used. Uranium-bearing minerals were first found by using a counter on the dumps of the old Ralston Creek prospect. The area has been explored by surface trenching, drifting and cross-

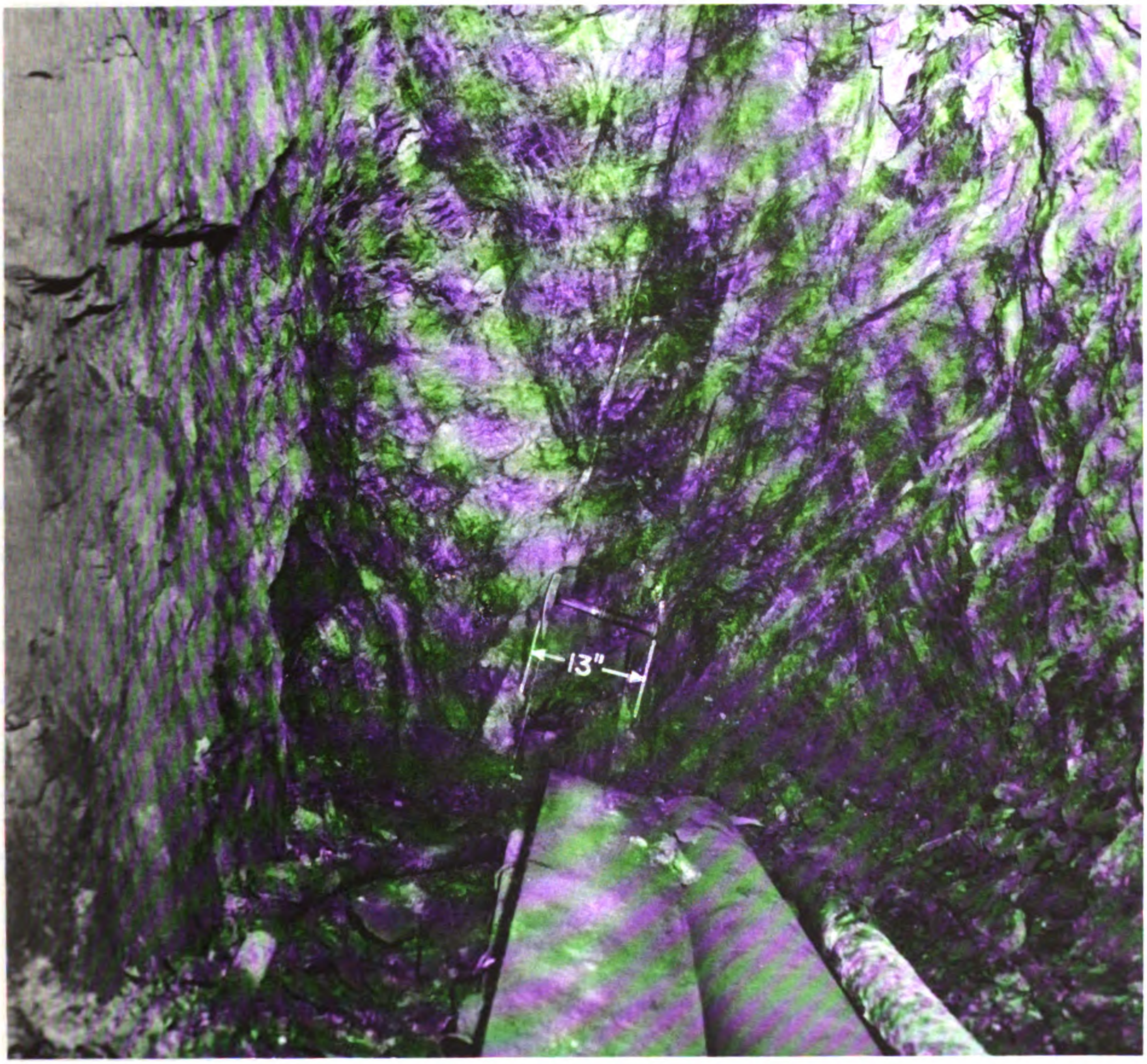

FIGURE 3. - Vein in Face of Drift.

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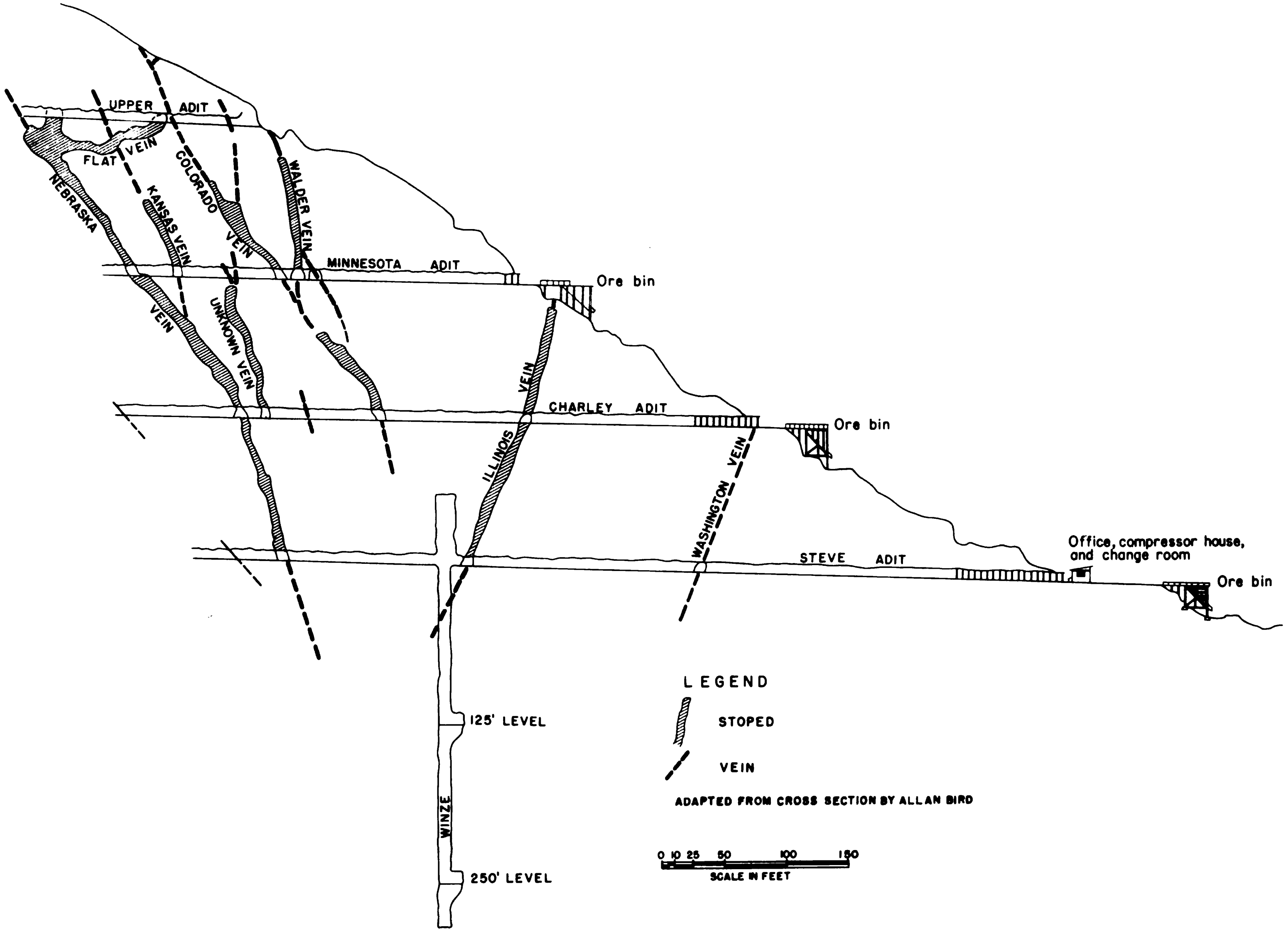

FIGURE 4. - Cross Section of Vein System.

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cutting underground, and diamond drilling, and counters are used to indicate the presence of uranium minerals. At present, most of the exploration is done by diamond drilling, and the mine operators have drilled over 5,300 feet of hole of AX size or larger. Before September 1, 1958, more than 11,000 feet of diamond drilling was done on the property.

METHODS OF SAMPLING

Most sampling is done with a geiger counter. With experience and proper calibration of the instrument, reliable results can be obtained. Because of the time lag between channel sampling and the receipt of chemical assays, counter results are relied on in stoping, except where the counter indicates a grade near the cutoff value. At such places, channel samples are taken and work is suspended pending receipt of the chemical assays. This procedure serves a dual purpose: (1) From time to time it provides a check on the use of a counter in sampling, and (2) where profitable ore is indicated it allows mining to be continued without waiting for chemical assays. The method has proved satisfactory.

METHODS OF DEVELOPMENT AND MINING

The Schwartzwalder mine is developed through adits, as shown in figure 4. The adits were driven to crosscut the veins, each succeeding adit being about 110 feet lower than its predecessor. Beginning with the top adit, the adits are named: Schwartzwalder, Minnesota, Charlie, and Steve. As the Steve adit is near the level of Ralston Creek, the lower levels are being developed through a winze, which later will be used as an underground shaft. The winze is 285 feet deep and was sunk from the Steve level, as shown in section in figure 4 and in plan in figure 5. Levels are being developed 125 and 250 feet below the Steve adit.

Development Details

The old sections of the upper, or Schwartzwalder, and Minnesota adits probably were driven by hand methods. All recent drifting and crosscutting has been done with compressed-air drills and loading machines. These openings are about 5 by 7 feet in cross section, although the drift widths may be greater depending upon thickness of the vein when drifting through ore. At present, all holes are drilled with a jackleg-type pneumatic hammer drill. Drill steel is 7/8-inch hexagonal hollow alloy steel with tungsten carbide inserts. The cutting edge is a chisel bit set integrally with the steel. Experienced miners are available, and no effort is made to adopt a standard round; the pattern of rounds is left to the miners. Some miners use a V-cut, whereas others prefer the burn cut. When mining was begun, rock was loaded by hand, but now a small, track-type overshot loading machine is used. Mine cars are 20-cubic-foot-capacity, end-dump type.

The winze from the Steve adit to the 125- and 250-foot levels is divided into two 4- by 4-1/2-foot compartments, one for hoisting and the other for a manway. The hoisting compartment has a skip for ore and waste. Figures 6 and 7 show details of the shaft timbering and framing and figures 8, 9, and 10 the

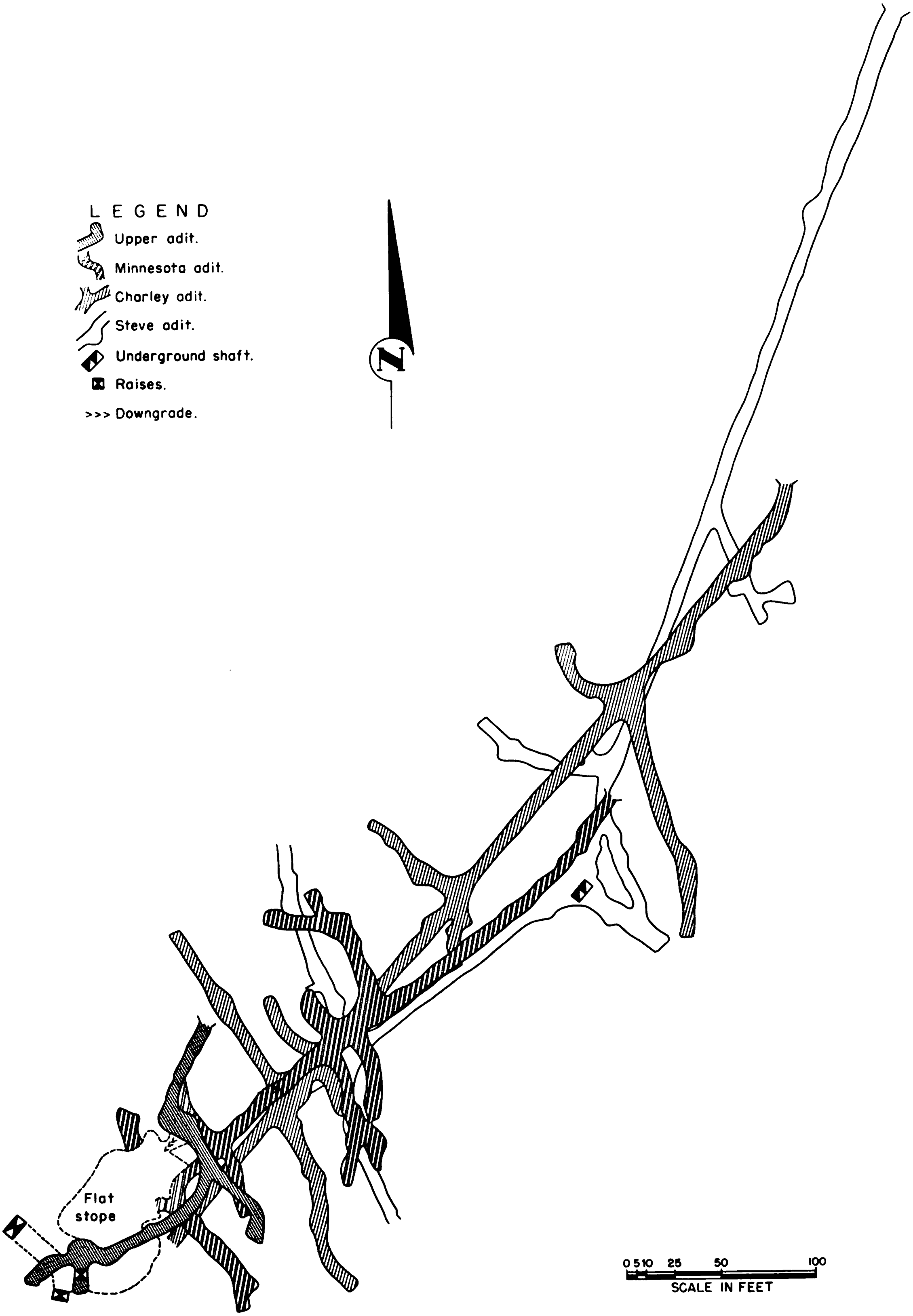


FIGURE 5. - Composite Level Plan.

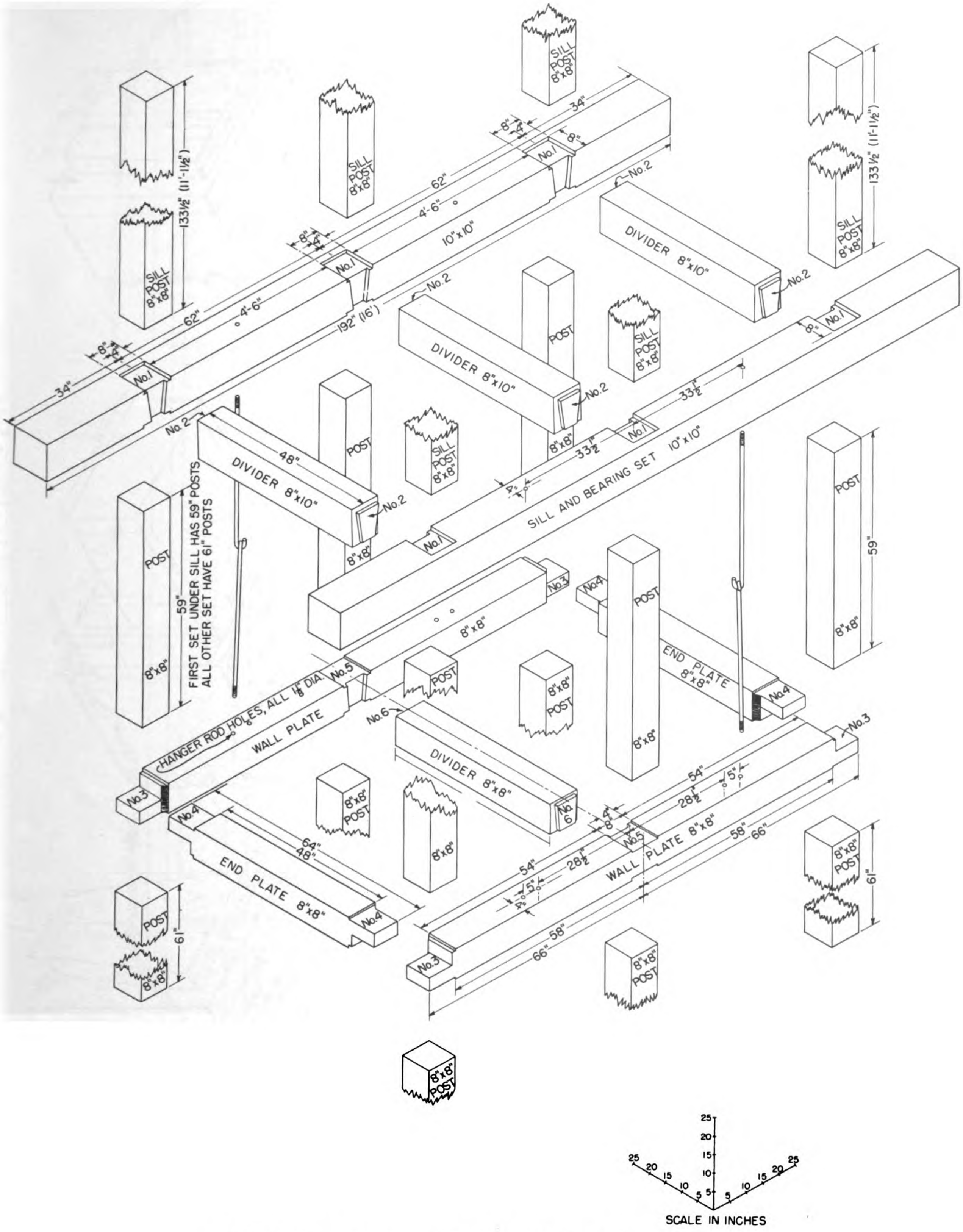


FIGURE 6. • Exploded View of Shaft Timbering.

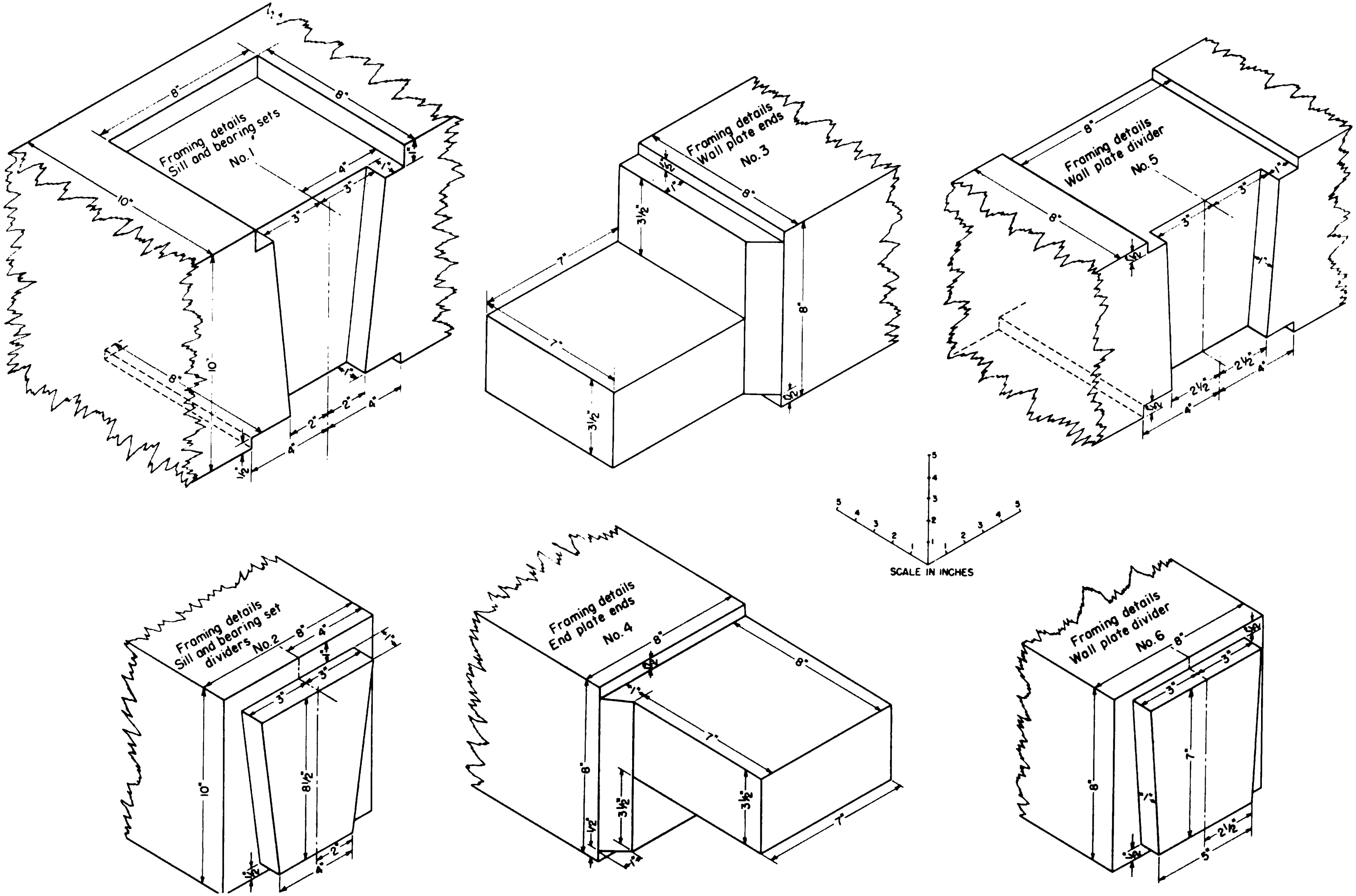
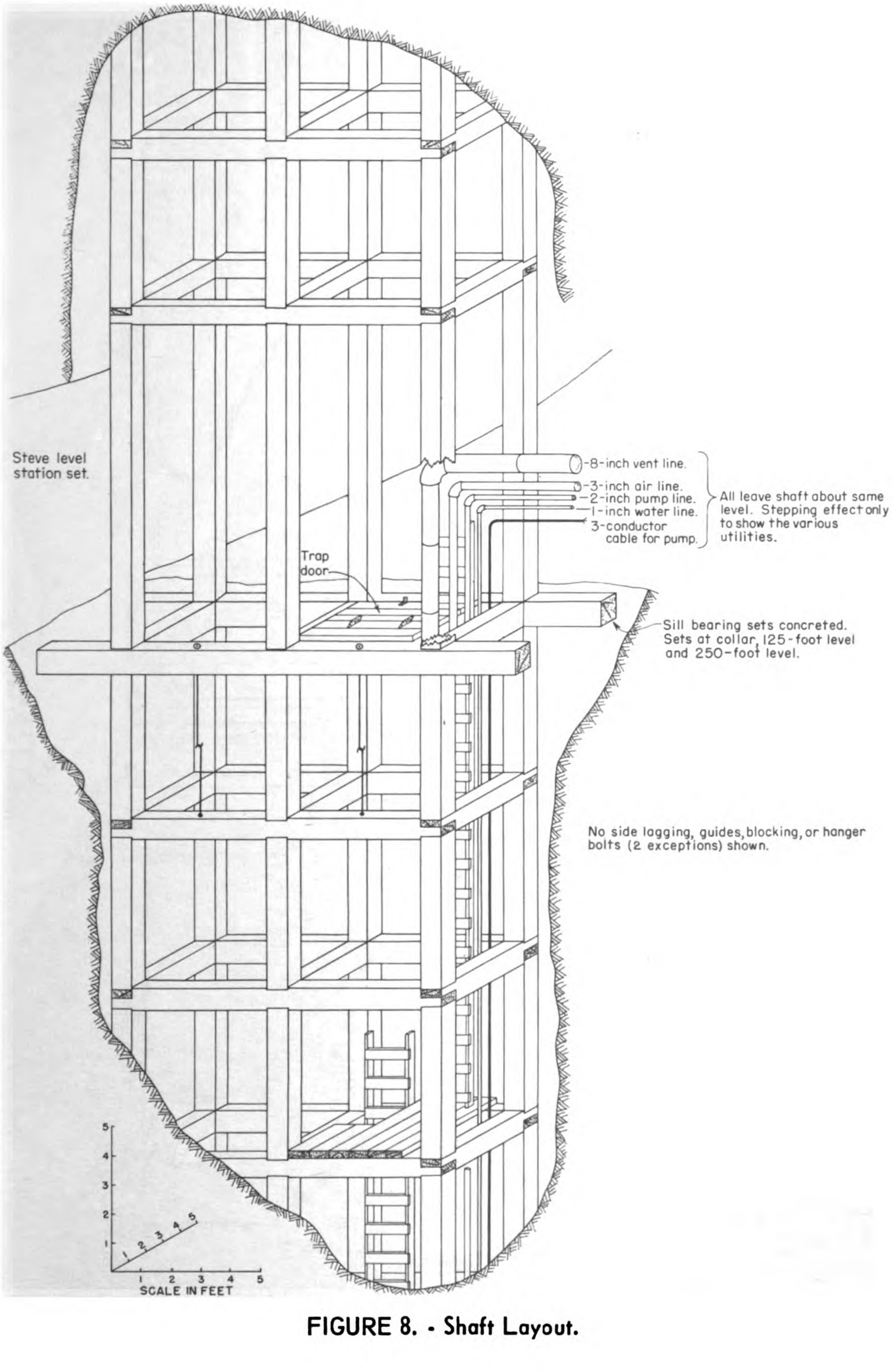


FIGURE 7. - Framing Details of Shaft Sets.



Steve level station set.

-8-inch vent line.
-3-inch air line.
-2-inch pump line.
-1-inch water line.
3-conductor cable for pump.

All leave shaft about same level. Stepping effect only to show the various utilities.

Sill bearing sets concreted. Sets at collar, 125-foot level and 250-foot level.

No side lagging, guides, blocking, or hanger bolts (2 exceptions) shown.

FIGURE 8. - Shaft Layout.

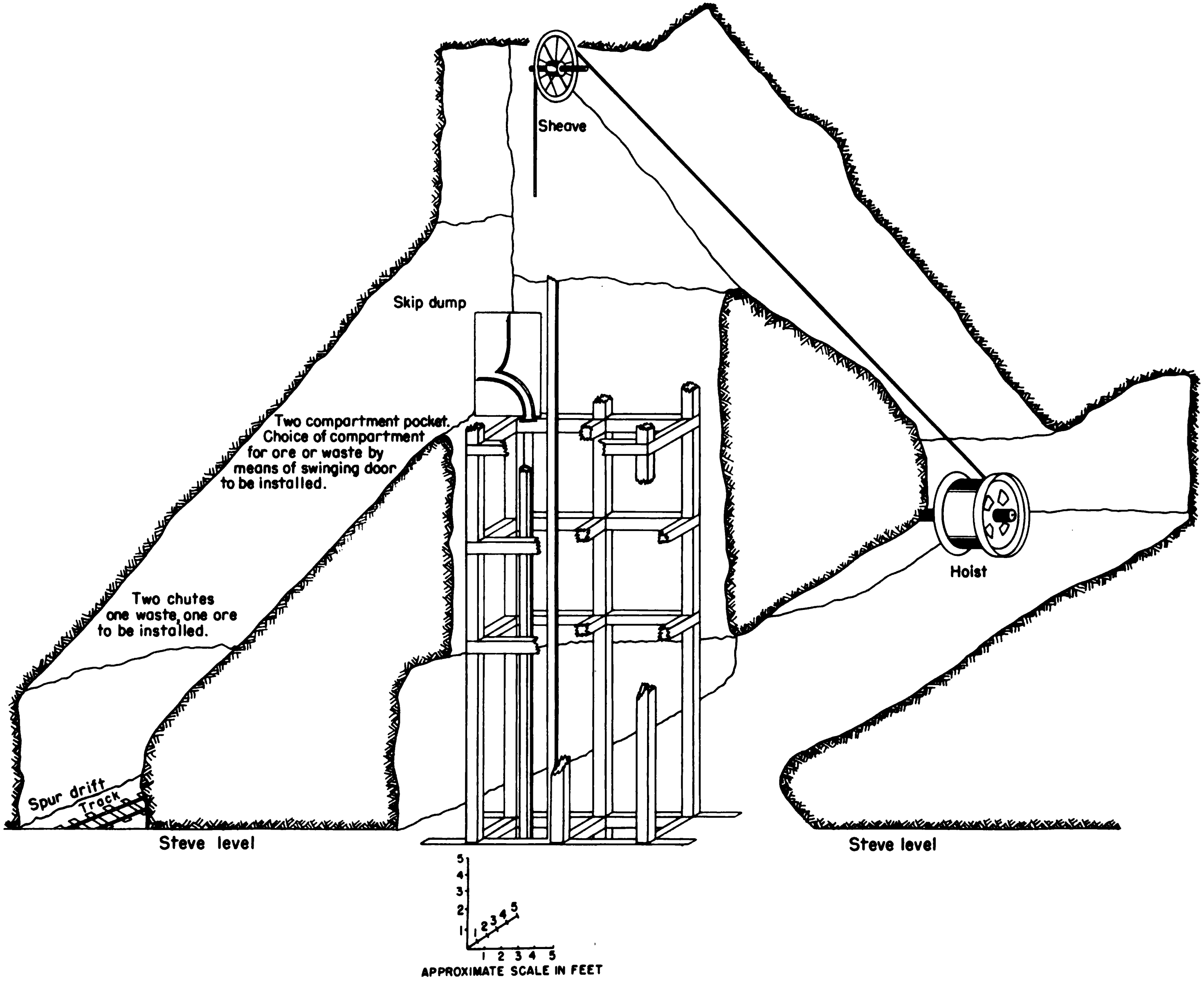

Sheave
Skip dump
Two compartment pocket. Choice of compartment for ore or waste by means of swinging door to be installed.
Two chutes one waste, one ore to be installed.
Spur drift
Track
Steve level
Hoist
Steve level
1 2 3 4 5
APPROXIMATE SCALE IN FEET

FIGURE 9. - Hoisting and Dumping Arrangement.

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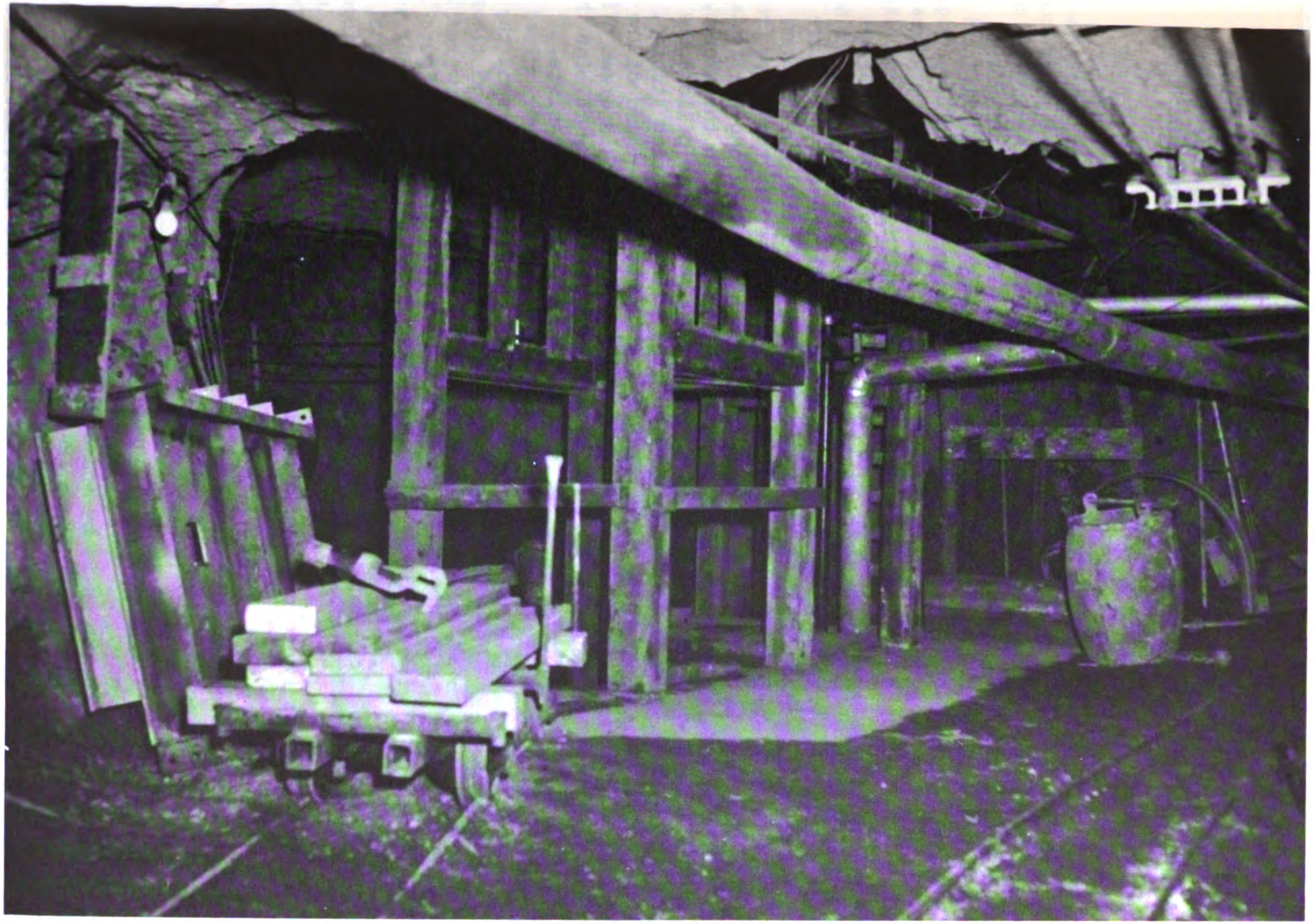

FIGURE 10. - Collar Station of Winze.

general setup at the collar station. All timber comes from local sawmills and is framed at the mine.

Most raises are driven for stope development and to provide access to stopes. The raises are 5 by 8 feet in section and are stulled. If in ore, they are driven to the level above in preparation for subsequent stoping.

Mining

The shrinkage-stope method is used in the Schwartzwalder mine. Both the hanging and foot wall are firm and stand well. No trouble has been experienced with dilution of the ore by waste material from the walls while drawing the ore or with caving after the stope has been drawn. Stopes are not waste filled. Raises for drawing the ore are driven on 15-foot centers along the drift and are flared at the top to meet the adjacent raise, leaving a chute pillar (fig. 11). Some early stopes had timbered drawpoints, and no rock pillar was left between these chutes. The present chutes are installed in the draw raises as the stope progresses along horizontal slices. In the stopes, only waste pillars are left. During stoping, about one-third of the broken ore is drawn off to make room to mine the next lift or slice. After a stope is mined and the ore drawn, the chute pillars and floor pillars are recovered if they are ore. Figure 12 shows a longitudinal section through a typical stope. In narrow stopes, the working floor is leveled by hand as required, and in the wider stopes a slusher hoist with a scraper is used to level the floor. Stopes have been mined up to 28 feet wide and average about 6 feet wide.

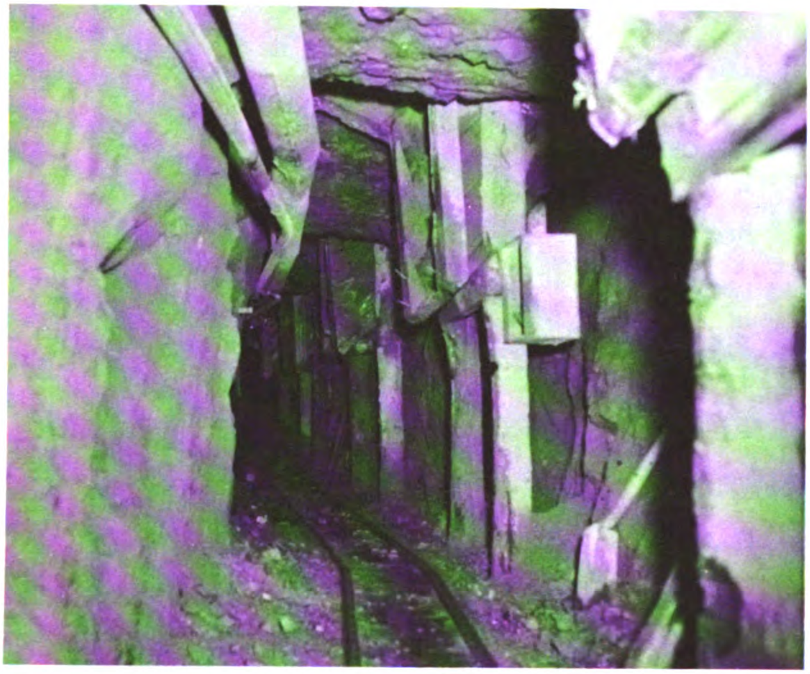

FIGURE 11. - Chutes Typical of Latest Operations.

Underground Transportation

Underground transportation is by end-dump mine cars of 20-cubic-foot capacity that run on light rails set to 18-inch gage. Workings are small-scale and short. Tramming is done by hand. An air trammer of 6-car capacity has been purchased. Most mine track is constructed of 16-pound rail, but some rail

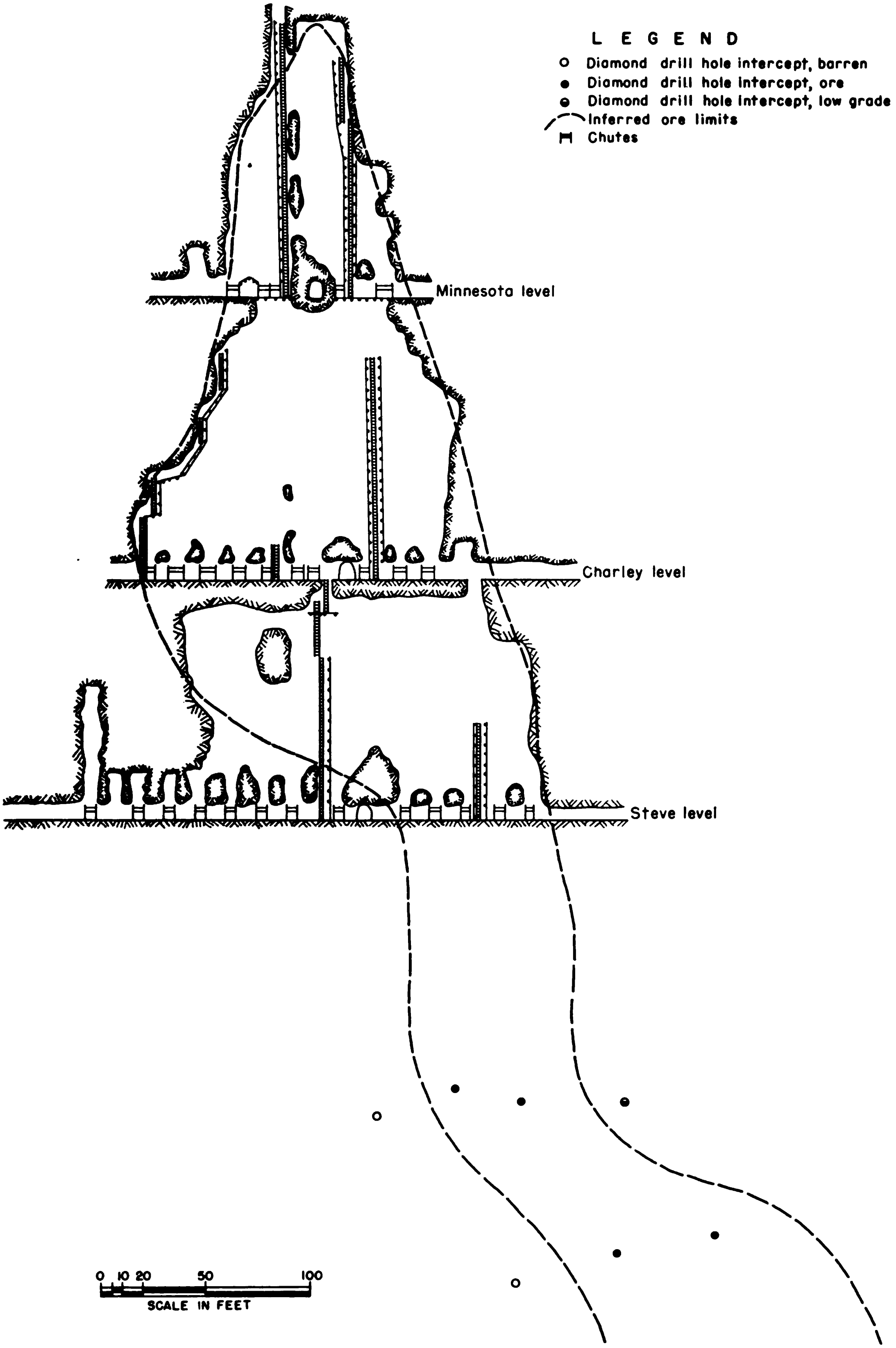
LEGEND
○ Diamond drill hole intercept, barren
● Diamond drill hole intercept, ore
⊙ Diamond drill hole intercept, low grade
Inferred ore limits
Chutes
Minnesota level
Charley level
Steve level
0 10 20 50 100
SCALE IN FEET

FIGURE 12. - Longitudinal Section of Nebraska Vein.

in the upper workings is of lighter weight. Haulageways are driven on a grade of 1 percent in favor of the load.

SURFACE INSTALLATIONS

Electric power was brought to the property in July 1958. Three-phase power enters a substation at 13,000 volts and is stepped down to 440 and 110 volts for mine use. About 400 hp. is available for operating the air compressors, mine hoist, pump, and other uses. About 73 percent of the power is used for air compressing, 19 percent for hoisting, 1 percent for pumping, 6 percent for ventilation, and the remaining 1 percent for miscellaneous uses.

A 28- by 64-foot prefabricated steel building houses the compressors, change room, and mine offices. Near the portal of the Steve adit are the lamp room, blacksmith shop, power substation, and office building. (See fig. 13.)

Stopes are not backfilled, so all waste must be disposed of outside the mine. The waste dumps and ore bins are near the portals of the adits. (See fig. 4, p. 8.) Waste-dump material is segregated if it contains appreciable uranium minerals.

SUPPLIES AND EQUIPMENT

A 45-percent semigelatin dynamite is used exclusively. Approximately 5,000 pounds is used each month, or about 2-1/4 pounds per ton of rock (waste and ore) broken. This converts to a cost of $0.55 per ton, of which 79 percent is for dynamite and the remainder for fuse, detonators, and igniters. The dynamite cartridges are 1-1/8 by 8 inches. All stope, raise, drift, and crosscut blasting is done with fuse and blasting caps. Lead spitters are used to ignite the fuse. Shaft blasting is done with electric blasting caps activated through a special 110-volt powerline. The following table shows the quantity and unit cost of explosives consumed during July, August, and September 1958.

TABLE 1. - Explosive consumption and cost

	Pounds	Cost
Per ton of ore to bin................	3.05	$0.75
Per ton of ore and waste broken......	2.24	.55

Dynamite and detonators are stored separately in underground magazines on the Steve level.

Integrally set tungsten carbide insert chisel bits on 7/8-inch hexagonal hollow alloy drill steel are used exclusively. Each bit is marked with a punched indentation at each sharpening to record the number of times it was sharpened. Bits are sharpened an average of 13 times before they are worn out and discarded. Some bits are sharpened as many as 17 times. The average rock drilled is hard and abrasive.

Little timber is used in the mine. Only the winze, chutes, and raises require timbering. Native ponderosa pine is delivered to the mine at a cost

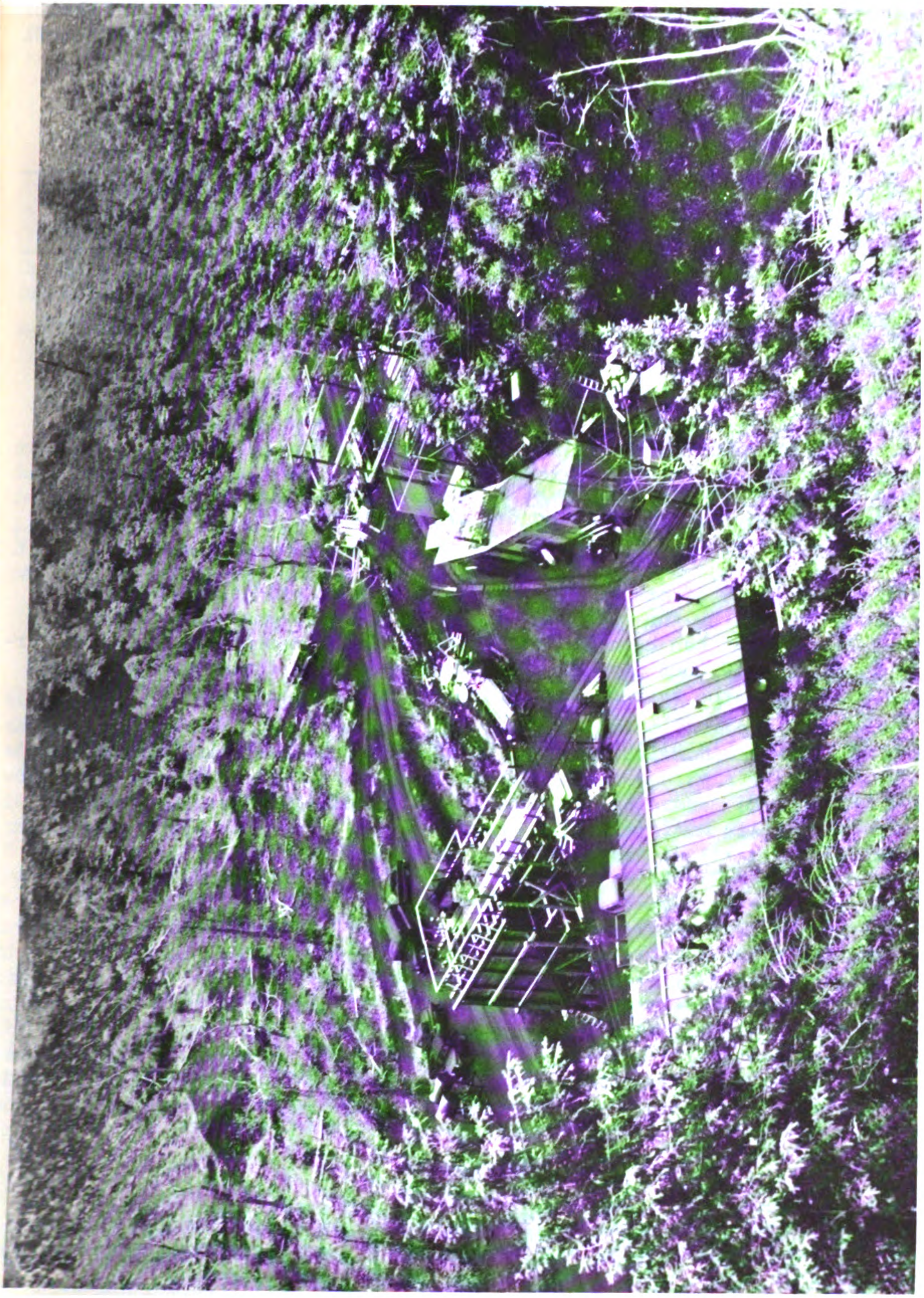

FIGURE 13. - Surface Installation at the Portal of Steve Adit.

of $70.00 per thousand board feet. Round timber stulls cost $0.14 per foot, and round lagging costs $0.07 per foot delivered. Track ties cost $0.34 each.

Major equipment at the mine includes the following:

Number	Item
2	Compressor, 600-c.f.m., 125-hp., electric-reciprocating, two-stage.
8	Mine car, end-dump-type, 20-cubic-foot.
3	Loader, track-type, small, overshot, for mine cars.
8	Rock drill, pneumatic-leg-mounted.
8	Stopers.
1	Electric hoist, 100-hp., 36- by 30-inch.
2	Fan, ventilating, 3,000-c.f.m., 7-1/2-hp.
1	Diamond drill, underground.
2	Lamp charger, 15-lamp-capacity, with rack.

PERCENTAGE EXTRACTION AND PRODUCTION RATE

Nearly 100 percent of the ore will have been extracted when all chute pillars and floor pillars containing ore are recovered. Pillars are left because they are waste.

Although 90 tons of ore or more per day has been produced, quantity restrictions imposed by the custom mill limit the daily production to about 75 tons. This amount can be mined efficiently under present conditions. Current production is 69 tons per day with 34 men, or 2.17 tons per man-shift. Tables 2 and 3 show the average work force and man-shift duty.

TABLE 2. - Labor classification for September 1958, Schwartzwalder mine

Number	Classification
1	Day foreman.
1	Night foreman.
1	Blacksmith.
1	Carpenter-timber framer.
2	Hoistmen.
1	Maintenance man.
1	Core-drill operator.
2	Trammers.
2	Powdermen (also bit sharpeners).
1	Utility (day).
6	Shaftmen.
15	Miners and muckers.

VENTILATION

The Schwartzwalder mine is ventilated by natural and mechanical means. All workings are open, allowing natural flow of air currents through the mine.

In dead ends, unconnected drifts and raises, and winzes, 3,000-c.f.m. fans force the air into working places through 8- and 12-inch ventilation pipe. Fans are installed at the portals of the Charlie and Steve adits.

TABLE 3. - Man-shift duty, Schwartzwalder mine, July, August, and September 1958

	Per shift	Per day	Per man-shift (all men)	Per man-shift (No major development)
Ore to bin.......tons...	35	69	2.17	3.30
Ore and waste broken..........do....	47	94	2.95	4.50

MINE DRAINAGE

Before the winze was sunk, mine water posed no problem as it drained off naturally through the adits. The mine contains enough moisture to allay the dust in most places. While sinking the winze, water caused no problem until a depth of about 250 feet was reached. At this depth, and estimated 15 to 20 g.p.m. entered the winze and a two-stage centrifugal electric pump rated at 200 g.p.m. at a 250-foot head had to be installed. About 2 hours of pumping per day was required to drain the winze.

WAGE, CONTRACT, LEASING, AND BONUS SYSTEMS

The force at the mine totals 34 men, excluding supervisors. Twenty-two men are on day shift and 12 on night shift. A foreman is in charge of each shift. A trammer, hoistman, and powderman, who also sharpens the chisel bits on the drill steel, work on each shift. An outside mechanic and a blacksmith work only on the day shift. The men work under a contract system in which a day's pay is guaranteed, and pay is based upon the number of units of work performed. Work on drifts and crosscuts, with a minimum cross section of 5 by 7 feet is paid at the rate of $10.50 to $11.50 per foot. Work on raises, 4.5 by 8 feet in cross section, is paid at the rate of $12.50 to $14.00 per foot. Work on the winze was paid at a rate of $60.00 a foot to a depth of 200 feet and $65.00 a foot from the 200-foot mark to the bottom at 285 feet. Excavating the stations was paid at a rate of $0.40 per cubic foot, and $0.50 per cubic foot was paid for excavating the sump. Stoping is paid at a rate of $0.23 per cubic foot. In the foregoing work, all supplies are furnished by the company; the labor is furnished by the contractor. During stoping, the contractor is responsible for keeping the stopes drawn to allow working room. About one-third of the broken ore is so drawn. After a stope is mined out, the remaining ore is removed on company account.

COSTS

The following figures were taken from company accounts and represent mining costs for for the 3-month period, July through September 1958. They are considered to be fairly representative of the consts of operating the mine. Tables 4 and 5 give the unit costs for tunnel driving and winze sinking. They are kept separate from stoping costs and may not be complete, but additional charges would change the average cost figures very little. Mining and stoping costs are presented in various ways because of the type of mining and the method of keeping accounts. In shrinkage stoping, the quantity of rock broken seldom equals the ore or the ore waste produced. Therefore, tables 6 and 7 are designed to show the unit costs per ton of ore to the bin and the costs per ton by rock broken.

TABLE 4. - Summary of crosscutting costs, Steve adit

Schwartzwalder mine
Crosscut to 605 feet

Item	Cost per foot
Supervision	$1.91
Labor	15.13
Explosives	2.94
Timber	.43
Drill Steel and bits	.80
Power	1.20
Transportation	.60
Geology and engineering	.35
Miscellaneous	2.15
Total	25.51

TABLE 5. - Summary of shaft sinking costs

Schwartzwalder mine
Winze, 285 feet deep
Duty, 756 man-shifts

Item	Cost per foot
Supervision	$6.02
Labor	78.66
Explosives	5.67
Timber	7.52
Drill steel and bits	1.53
Power	6.36
Rail	4.85
Miscellaneous	2.42
Total	113.03

The major mine development is carried as a separate account. Table 6 shows the unit cost per ton, based on stoping and its allied development, drifting, and raising but no major development. Table 7 includes all major development.

TABLE 6. - Summary of stoping costs

Schwartzwalder mine
Tons ore to bin: 5,337

July, August, and September 1958
Tons ore waste broken: 6,616

Shrinkage stoping

Items	Supervision	Labor	Bits (steel)	Explosives	Timber	Power	Transportation	Prospecting	Maintenance	Miscellaneous	Total
Ore to bin:											
Stoping..............	$0.74	$3.04	$0.22	$0.76	$0.19	$0.33	$0.19	$0.44	$0.11	$0.73	$6.75
Development in ore....	.08	.72	.03	.08	.02	.03	.02	.05	.01	.08	1.12
Development in waste..	.02	.15	--	.02	--	.01	--	.01	--	.02	.23
Mining total..........	.84	3.91	.25	.86	.21	.37	.21	.50	.12	.83	8.10
Ore and waste broken:											
Stoping..............	.60	2.45	.19	.61	.15	.26	.15	.36	.08	.60	5.45
Development in ore....	.07	.58	.02	.07	.02	.02	.02	.04	.01	.07	.92
Development in waste..	.01	.12	--	.01	--	.01	--	.01	--	.01	.17
Mining total..........	.68	3.15	.21	.69	.17	.29	.17	.41	.09	.68	6.54

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TABLE 7. - Summary of mining costs

Schwartzwalder mine
Tons ore to bin: 5,337

July, August, and September 1958
Tons ore and waste broken: 7,270

Shrinkage stoping and major development

Items	Super-vision	Labor	Bits (steel)	Explo-sives	Timber	Power	Transpor-tation	Prospecting	Main-tenance	Miscel-laneous	Total
Ore to bin:											
Stoping...............	$0.74	$3.04	$0.22	$0.76	$0.19	$0.33	$0.19	$0.44	$0.11	$0.73	$6.75
Development in ore....	.08	.72	.03	.08	.02	.03	.02	.05	.01	.08	1.12
Development in waste..	.30	2.70	.07	.12	.05	.05	--	.01	--	.15	3.45
Mining total..........	1.12	6.46	.32	.96	.26	.41	.21	.50	.12	.96	11.32
Rock broken:											
Stoping...............	.61	2.87	.17	.52	.14	.22	.11	.27	.06	.53	5.50
Development in ore....	.07	.60	.02	.06	.02	.02	.01	.03	.01	.06	.90
Development in waste..	.14	1.27	.04	.12	.03	.05	.03	.06	.01	.12	1.87
Mining total..........	.82	4.74	.23	.70	.19	.29	.15	.36	.08	.71	8.27

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